REMARKS

The indicated allowability of claims 6, 14-24, 26-30, 32, 33, 35, and 38-41 is acknowledged with appreciation. After careful review of the Office Action outstanding in this application, Applicants have amended claims 3 and 12 and have added new claims 42-47 to provide the scope of protection to which they are believed entitled. Accordingly, favorable reconsideration of the application is respectfully solicited.

The present invention relates to a novel technique for producing unidirectionality in semiconductor photonic devices such as ring lasers and V-shaped lasers, based on the use of an etched gap or gaps in the laser waveguide to enhance the side-mode suppression ratio of such lasers where each gap is defined by spaced-apart parallel etched facets. The invention is further directed to the use of a facet at or near the Brewster angle on a photonic device coupled to a laser to prevent back-reflection.

In a preferred form of the invention, semiconductor lasers incorporate at least one gap which is provided by etching through the cavity of a monolithic ridge-type ring or V-shaped laser integrally fabricated on the surface of a substrate. In another embodiment, multiple gaps may be etched in spaced-apart pairs along a laser segment, with the portion of the waveguide segment between the gaps being offset to compensate for refraction at the etched facets. In another form of the invention, the laser output is coupled to the near end of a photonic device, with back-reflection being minimized by providing a facet at the Brewster angle at the distal end of the photonic device.

In the Office Action, claims 1-3 have been rejected under 35 U.S.C. 102(e) as being anticipated by Sirbu et al (6,546,029). In support of this ground of rejection, it is asserted that Fig. 3 of Sirbu discloses a monolithic semiconductor laser cavity 100 having one segment and an output, an etched gap 16 extending through the segment, and a distributed Bragg reflector 12(a), and thus anticipates claim 1.

With respect to claim 2, it is asserted that the laser cavity disclosed in Fig. 3 has a total length of between 10 and 10,000 micrometers, and with respect to claim 3, it is asserted that the reference discloses an etched gap having a length of between 0.001 and 10 micrometers, citing col. 4, line 56 of the reference.

In response, it is respectfully submitted that Sirbu in fact does not disclose a "monolithic" semiconductor laser cavity, but instead discloses a device in which multiple layers are separately fabricated, aligned, and then fused to produce the final structure. See the description of Figs. 4 and 5 at col. 6, lines 32-64 of the reference. A monolithic device is formed from a single crystal, whereas Sirbu shows multiple crystalline substrates joined to form a tunable air gap cavity. Sirbu does not disclose an etched gap in a monolithic structure, and accordingly the rejection under 35 USC 102 of claims 1-3 is not supported by the reference; its specific teachings are contrary to the features recited in claims 1-3 of the present invention.

With respect to claim 2, it is asserted that the cavity in Fig. 3 has a total length of between 10 and 10,000 micrometers. Applicants are unable to find any teaching in this reference that would support this assertion. The discussion of Fig. 3 states that the spacer 17 "has a total thickness of 1.5 μm", but no other dimensions are given. Since

the asserted teachings concerning the claimed cavity length are not found in the reference, the rejection under 35 USC 102 cannot be sustained.

With respect to claim 3, it is respectfully pointed out that the claim defines a laser cavity segment incorporating an active region, with an "etched gap" having "spaced-apart etched facets" extending through the active region. No such features are found in Sirbu. The recess 16 in spacer 17 is said to be etched, but nothing in the reference suggests that the etching of this recess results in "etched facets" that extend through the active region of a laser cavity. Furthermore, since there are not etched facets disclosed, the reference cannot teach a gap of between 0.001 μm and 10 μm between etched facets. Accordingly, claim 3 is clearly patentable over the reference under 35 USC 102.

Claims 4, 5, 7-12, 25, 31, 34 and 36-37 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Sirbu et al in view of Spitzer (5,241,555). It is admitted in the Office Action that Sirbu does not disclose a photonic device connected to an output of a laser cavity, does not show a laser in the shape of a ring, and does not show a facet at the Brewster angle. However, it is asserted that Spitzer teaches the missing features.

The patent to Spitzer discloses a semiconductor single crystal external ring resonator cavity 12 having a "plurality of reflecting surfaces defined by the planes of the crystal" to establish a closed optical path 22. A discrete laser medium 24 is disposed on the semiconductor single crystal external ring resonator for generating coherent light in the cavity. The laser medium 24 may be grown epitaxially on the semiconductor crystal

and may be oriented at the Brewster's angle with respect to the optical path 22 of the cavity to eliminate reflections and back scattering. The reflecting surfaces of the external ring cavity of Spitzer are illustrated at 14, 16, 18 and 20, and are established by cleaving along the crystal planes (col. 5, lines 56, 57) to establish a closed optical path. Although the laser 24 is positioned at the Brewster's angle to the optical path, as described at column 5 of the patent, there is no disclosure of a facet at the Brewster angle.

It is asserted in the Office Action that it "would have been obvious to one of ordinary skill in the art.....to use the ring shape and Brewster's angle orientation disclosed in Spitzer with the laser disclosed in Surbin for improved performance and application of the device as disclosed in Spitzer".

This ground rejection is respectfully traversed for the reason that the combination asserted in the Office Action is totally unfounded; there is absolutely no teaching in the two references that would support any of the statements made concerning the modifications of the two references. First of all, it is noted that the "application of the device as disclosed in Spitzer" is as a gyroscope, and the present claims are not directed to such an application. Secondly there is no suggestion in Sirbu to support the assertion that the Sirbu device could be formed in a ring. Sirbu is a tunable Fabry-Perot vertical cavity device having a deflectable membrane, and nowhere mentions the possibility, much less the desirability, of making such a structure part of a ring cavity. Spitzer is a ring cavity, but nowhere suggests how the Fabrey-Perot structure of Sirbu could be fabricated as a ring. It is fundamental to the patent law that in order to

combine the teachings of references under 35 USC 103, there must be a clear teaching of the combination in the references themselves. There is no such teaching here.

The asserted teaching of a Brewster's angle in Spitzer utterly fails to address the features claimed in the present application. Spitzer shows a laser 24 that is outside of the ring cavity 22 and which injects light into the cavity. The light is injected at an angle to the axis of the cavity, but that is not what is recited in the present claims.

More particularly, claim 4 is dependent on claim 1, and distinguishes over Sirbu for the reasons discussed with respect to that claim. Furthermore, claim 4 recites a photonic device connected to an output of the laser cavity. Sirbu does not show or suggest such a feature. Furthermore, Spitzer fails to show a photonic device connected to an output of the laser; to the contrary, the laser 24 of Spitzer is connected to an input of the cavity 22. Accordingly, Spitzer cannot teach the use of a photonic device at an output of Sirbu, and claim 4 is clearly patentable.

Claim 5 is dependent on claim 1, and defines the laser as a ring having multiple segments joined end-to-end. Although the Office Action asserts that Sirbu could be modified to form a ring structure, applicants inquire how that would be done. Certainly the solid-state device of Spitzer does not teach such a modification of Sirbu, and neither reference gives a reason why such a modification should be made. Certainly Spitzer doesn't suggest that Sirbu should be made into a ring to obtain "improved performance", as asserted in the Office Action, for Spitzer says nothing at all about improving the performance of a tunable Fabry-Perot vertical cavity device. The asserted combination

is clearly based solely on a desire to find a disclosure of the basic terms of the claims, without concern for the structure actually being claimed. Such a rejection cannot stand.

Claim 7, is an independent claim which recites a monolithic semiconductor laser cavity, and thus clearly defines over Sirbu, as discussed above. The claim further recites an etched gap extending through the segment, a feature nowhere disclosed in the references, and certainly not suggested by the etched cavity of Sirbu. The claim also recites a photonic device coupled to an output of the laser with an etched facet at the Brewster angle near one end of the photonic device. As discussed above, Spitzer does not disclose a photonic device having an etched facet at Brewster's angle, and accordingly the references do not teach or suggest the claimed structure. Similarly, claim 10 is an independent claim that defines a photonic device having an etched facet at the Brewster angle, and such a structure is neither disclosed nor suggested by either Sirbu or Spitzer. The latter reference mentions Brewster's angle, but that has reference to the angle of impingement of light on an input to a cavity, and is not a teaching of a photonic device having an etched facet at the Brewster angle.

Claims 8 and 9 recite dimensions of the cavity and the gap, and define over the references for the reasons discussed above with respect to claims 2 and 3.

With respect to claims 11 and 12, it is asserted that Spitzer discloses a "cavity (26)" that includes entrance and exit facets. However, it is respectfully submitted that Spitzer teaches no such thing. The element 26 is a "chamber" (see col. 5, line 29) filled with a transparent epoxy, and this clearly is not a laser cavity. Instead, this material serves to match the index of refraction of the crystal 12 with the index of refraction of

laser 24. As pointed out at col. 3, lines 13-16, when such an indexing material is used, there is no need to orient the laser at a Brewster's angle. Further there is no suggestion that either medium 26, or the ends of the laser 24 are etched facets, or that one of them is at a Brewster's angle.

Claim 25 is an independent claim which recites a monolithic solid state waveguide cavity having etched entrance and exit facets and an etched gap defined by a pair of parallel etched facets extending through the solid state cavity and spaced apart by a defined distance. It is asserted in the Office Action that Sirbu teaches a waveguide cavity having etched entrance and exit facets at col. 3, lines 20-23 and 40-51, and an etched gap (16) extending through the cavity between the entrance and exit facets.

It is respectfully submitted that Sirbu in fact does not disclose the claimed structure at col. 3, lines 20-23; the reference merely describes a deflectable membrane. At col. 3, lines 40-51, the reference describes a method of forming the top DBR stack (12a) above a central region of the recess 14, wherein the DBR layers are etched to form a mesa having a lateral dimension smaller than the lateral dimension of the recess (see Fig. 1 of Sirbu). This is not a teaching of the claimed structure, and does not describe either entrance or exit facets or an etched gap. Accordingly, the claim clearly defines a structure not found in Sirbu, and the claim is clearly patentable.

With respect to claim 31, which is dependent on claim 1, Fig. 9 of Spitzer is asserted as showing a ring cavity having two segments joined at an etched facet 16. However, Spitzer states at col. 5, lines 25-28 that facet 16 is cleaved, not etched.

Furthermore, facet 16 is internally reflective, and is not an output facet, as required by claim 31, so clearly the claim is patentable over the references.

It is asserted that the "etched gap" of Sirbu "would extend through one of the segments if the laser disclosed in Sirbu would be used as the laser disclosed in Spitzer (24)". However, there is no teaching in either of the references to support the assumption that the tunable cavity of Sirbu could (or should) replace the laser 24 in Spitzer. That is a substitution that is founded solely in a desire to meet the terms of claim 31, and finds no support in the teachings of the references. Where in Spitzer is it suggested that the laser 24 should (or could) be a tunable vertical cavity device? There is no such teaching, so the assertion made in the Office Action is without support, and the claim is clearly patentable.

With respect to claims 36 and 37, which are dependent on claim 31, it is asserted that the claimed etched gap is met by the "etched gap 16" of Spitzer. This is clearly not the case, for Spitzer shows no etched gap. The facet 16 is cleaved, as noted above, and there is no gap formed by spaced-apart etched facets in either Spitzer or Sirbu. Further, the facet 16 of Spitzer is not perpendicular to the optical axis of the device, as required by claim 37. In addition, Sirbu fails to disclose etched facets in Fig. 3. As described with respect to Figs. 4 and 5, the recess 16 is formed in layer 17, and thereafter, the recess is covered by membrane 18. There is no teaching of spaced etched facets, and accordingly claims 36 and 37 are patentable over these references.

Claim 13 has been rejected over the combined teachings of Sirbu, Spitzer and Zoll, it being said that Zoll teaches a V-shaped laser 10 that produces a nonlinear light path, referring to col. 2, lines 3-8 of Zoll.

As discussed in the previous response, the patent to Zoll discloses a V-shaped resonator which has first and second channels for receiving a laser beam. The resonator includes adjustable mirrors fixed to the housing so that the resonator can be transported and installed. There is no teaching in this reference that would suggest that Sirbbu or Spitzer, or the two together, could be formed in a V-shape, for Zoll itself does not disclose a V-shaped laser. As illustrated in Fig. 1 of the Zoll patent, the only laser is shown at 1, and it is not V-shaped. It supplies light through a filter 4 to two cavities 9 and 10, with the channel 9 incorporating a sample which is to be monitored. This is not a teaching of a V-shaped laser, nor is there any suggestion of a nonlinear light path, contrary to the assertion in the Office Action. The reference to col. 2, lines 3-8 of Zoll is not understood, for there is no teaching of a nonlinear light path at this point.

Zoll does not suggest that the Sirbu device could be fabricated in a V-shape for there is no teaching in Zoll as to how that could be accomplished without destroying the entire purpose and function of the Sirbu invention. As pointed out above, Switzer provides no suggestion of how to make Sirbu into a ring structure, and Zoll provides no teaching of how to convert the closed ring structure of Switzer into a V-shaped structure without destroying the Switzer device. If one were to try to reposition the ring of Switzer into a V-shape as suggested by the Office Action, Applicants inquire where the laser 1 of Zoll would be positioned in the resulting device, since Zoll does not teach V-shaped

lasers. It is respectfully submitted that the references do not suggest how such a reconfiguration of Sirbu and Switzer could be accomplished to produce an operational device, and do not suggest what that operation would be. Any attempt to restructure Sirbu and Switzer in the manner suggested in the Office Action would destroy these devices, and would not result in the claimed invention.

As noted above, Claim 13 defines a photonic device as having a V-shaped structure with the at least one segment including a first and a second leg. As pointed out above, Zoll does not suggest that a ring laser such as that of Spitzer could be V-shaped, nor does it suggest that Sirbu could be in a V-shape, particularly if Sirbu is modified by Spitzer. The assertion in the Office Action that the formation of the Sirbu and Spitzer devices in a V-shape would improve device stability and reliability is simply without support in the references, for neither reference makes such a suggestion. Obviously, the Office Action relies solely on Applicants' disclosure for this conclusion.

It is respectfully submitted that the references, taken singly or in combination, cannot teach the invention set forth in the claims of the present application under either 35 U.S.C. 102 or 103, for the references clearly have no teachings that would support such rejections. It appears that all of the grounds of rejection are based on Applicants' own disclosure, with the references being selected in accordance with Applicants' teachings, not in accordance with the teachings of the references themselves. Accordingly, reconsideration and allowance of the claims is requested.

New claims 42-47 have been added to provide additional coverage for the invention described herein. Independent claim 42 is similar to claim 1, but with

additional details to further define over the references for the reasons discussed above. Furthermore, additional features of the invention are recited in claims 43-47 to further define over the cited references. These claims are believed to be clearly in condition for allowance.

The claims now in the application are believed to clearly define over the references, and are believed to be allowable. Favorable reconsideration is respectfully solicited.

Respectfully Submitted,

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